U.S. DEPARTMENT OF ENERGY
SOLAR DECATHLON
2011

A Discussion on Electric Vehicle Charging

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Pepco Holdings, Inc.

3 states and Washington DC in mid-Atlantic US

Transmission & Distribution – 90% of Revenue

atlantic city electric
A PHI Company

delmarva power
A PHI Company

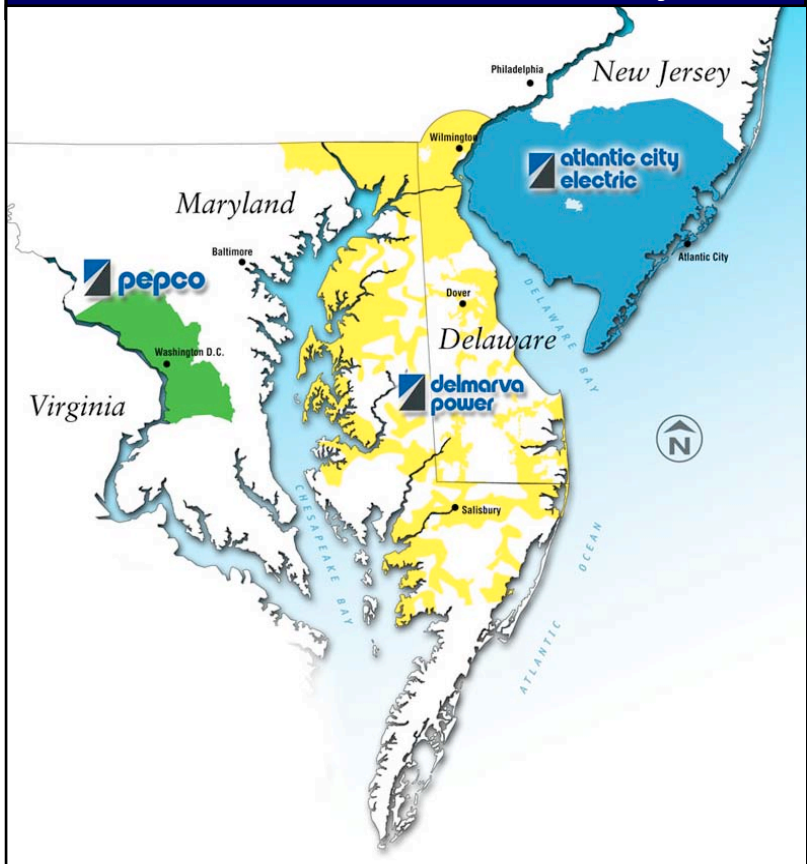
pepco
A PHI Company

Competitive Energy / Other

pepco Energy Services

PHI Investments

Combined Service Territory



Regulated transmission and distribution is PHI's core business.

Investing in the Smart Grid

Smart Grid benefits to the customer…

Puts decision making in the hands of customers

- **Improved information, programs and pricing options will allow customers to make informed energy choices**
- **Gives customers better information about their service and use**

Automatically accommodates changing conditions

- **Fault isolation, quick automatic restoration, advanced grid sensors**
- **Reroute power flows, change load patterns, improve voltage profiles**
- **Automatic notification for corrective actions and maintenance activities, which minimizes workforce intervention**

Enables us to operate the system with greater efficiency

- **Better asset management by optimizing grid design and investments**
- **Optimized grid operations, reduce losses**
- **Greater reliability and security**

Promotes green energy initiatives

- **Enables participation of distributed, renewable energy resources and plug-in electric vehicles**
- **Providing enhanced monitoring and control capabilities**

PHI History with Electrical Vehicles

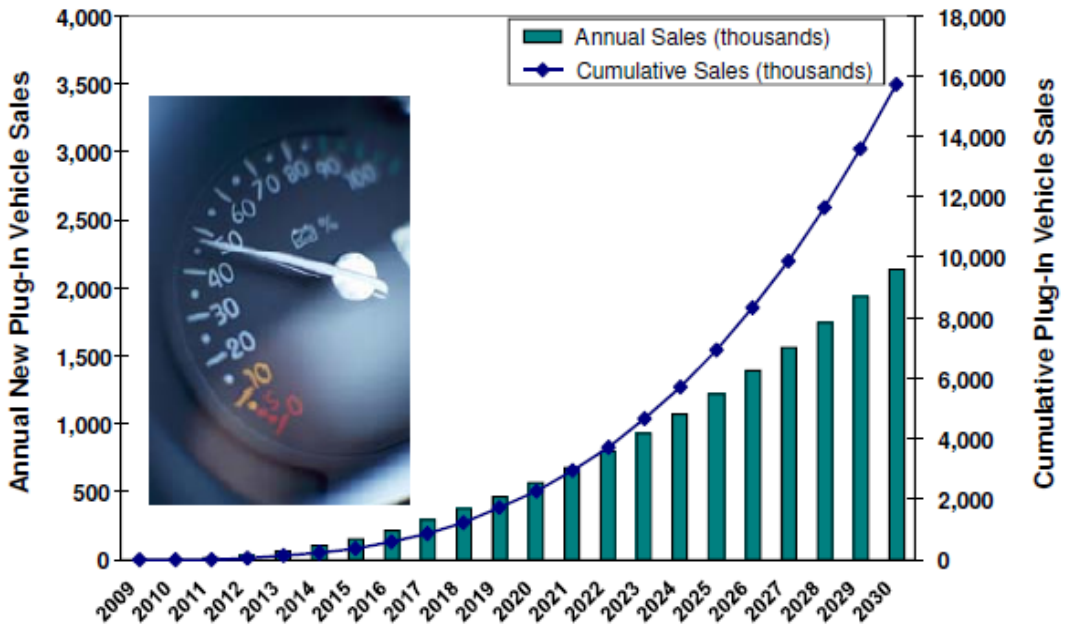
- Member of DOE Site Operator Program
  - Maintained a fleet of 6 all-electric conversion vehicles
- Founding Member of EV America
  - Developed first utility standards for electric vehicles
  - Later turned over to DOE
- GM PrEView Drive Program
  - 60 customer drivers for two weeks at a time
  - Installed over 75 Level 2 chargers
- Toyota RAV4 EV Program
- Ford Ranger EV Program

Plug-In Vehicles are coming….

- Penetration projections are inconsistent
- Initial Impacts to infrastructure will be due to clustering
- Significant penetration is still years away
- Washington, DC region is expected to be any early target market for several manufacturers

OEM Deployment in the Pepco Region

Ford Transit Connect	2010
Chevy Volt	2011
Nissan Leaf	2011
Ford Focus	2011
Ford PHEV	2012
Fisker Nina PHEV	2012
Tesla	2012
BMW Megacity	2013

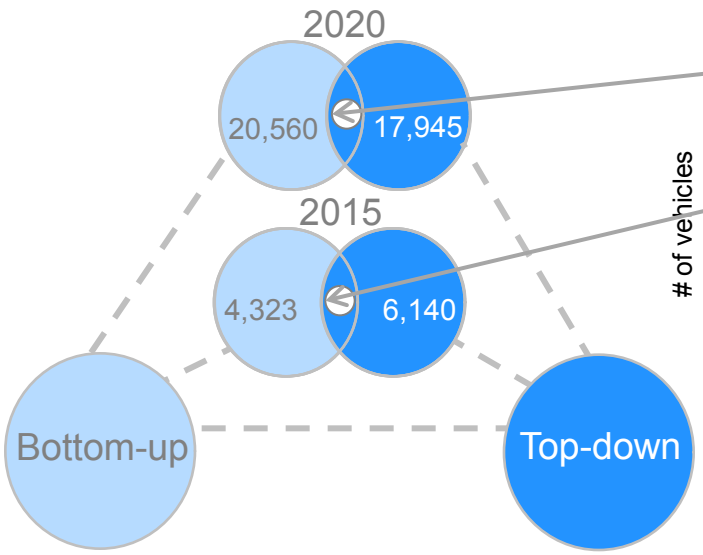


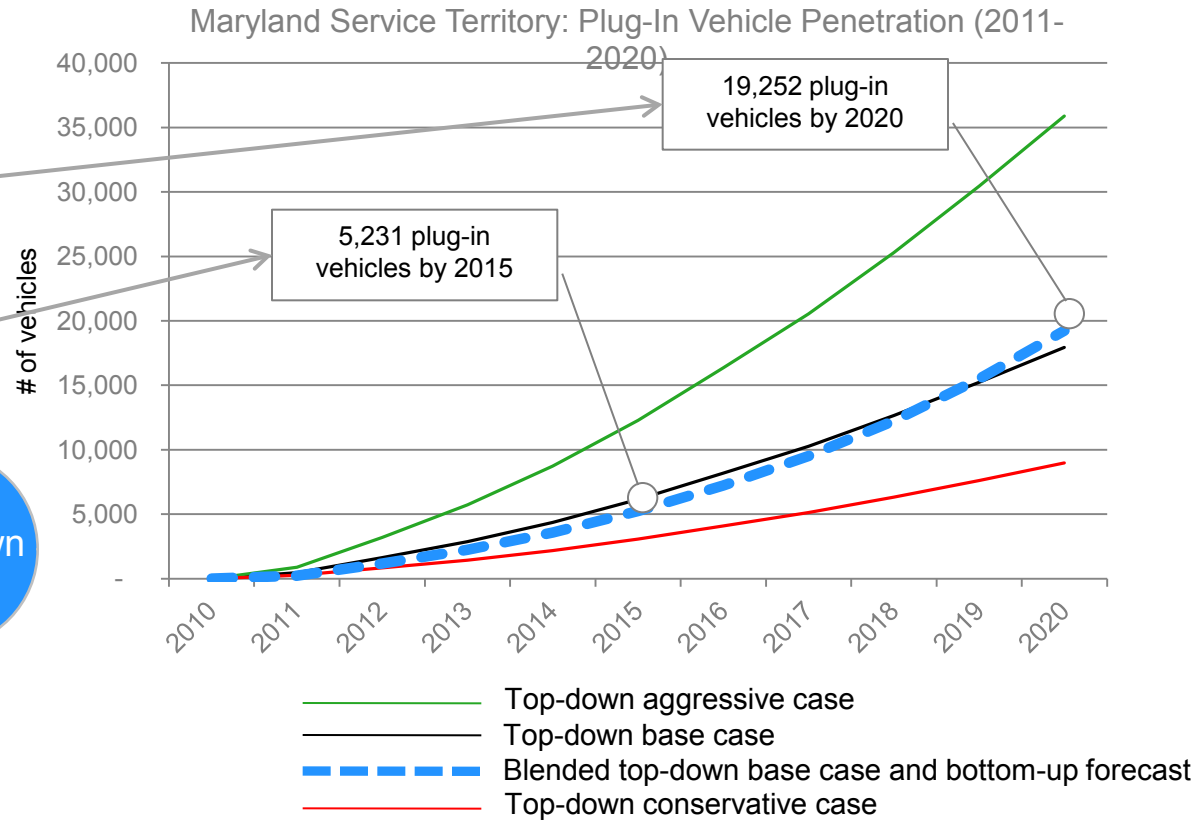
Regulatory Landscape

	Electric Vehicle Initiatives	Energy Reduction Goals
New Jersey	*State Introduced legislations related to public charging at State toll roads rest areas and New Shopping Center Development. There is also tax credits for purchases of vehicles*	*NJ State goal of reducing energy consumption and GHG emissions by 20% by 2020*
Maryland	*Recently Introduced legislation related to:* 1) *Utilities Demand response for charging EV's,* 2) *Tax Credits for EVSE' and* 3) *creating MD EV's Infrastructure Council*	*EmPOWER Maryland initiative aims to reduce electricity consumption in the state by 15% by 2015*
Delaware	*No Significant Activities*	*Similarly, DE has a program to reduce electricity consumption by 15% by 2015*
District of Columbia	*No Significant Activities*	*DC has a number of energy reduction goals, including a proposed reduction of GHG emissions by 30% by 2020*

Projecting PEV Growth

PHI has built a set of projections covering PEV take-up in each of its jurisdictions, using both top-down and bottom up techniques. In this example, the forecast covers the Maryland service territory.

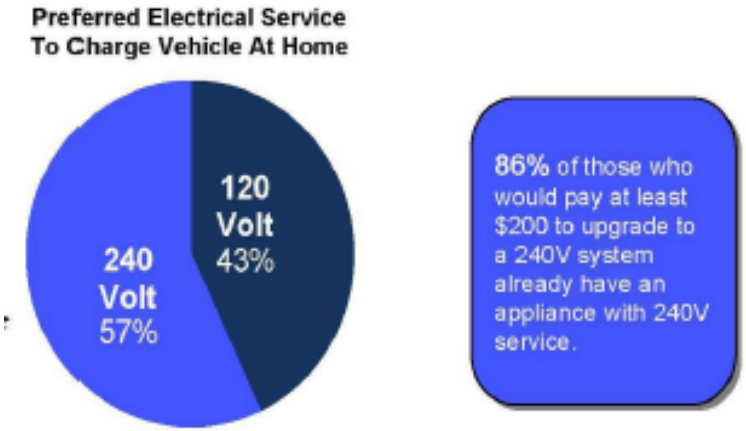




Triangulating both forecasts reveals very similar projections. Taking the mid-point between the two yields 5,231 plug-in vehicles in 2015 and 19,252 in 2020.

EVs Need High-Powered Chargers

- Most vehicles will come with a Level 1 charger (120V home outlet)
- Level 2 charging required for overnight charging of larger batteries
- Faster charging also allows higher efficiency, smaller battery
- Customers surveyed preferred Level 2 chargers
- Cost of installation is a potential issue
  - 75% of existing hybrid owners would pay at least $200
  - PrEView Program showed $1200 average installation cost
  - ***May require installation incentive.***



	Voltage / Current	Power	Chevy Volt (8 kWh)	Nissan Leaf (24 kWh)
Level 1 	120V @ 12A	1.4 kW	6 hours	17 hours
Level 2 	240V @ 32A	7.7 kW	3.5 hours	3 hours
	240V @ 70A	16.8 kW	½ hour	1.5 hours

Plug-In Vehicles' Impact on Load

The following analysis was based on a number of assumptions, including:

Plug-in electric vehicles (PEVs) / consumption:

- An individual PEV will use 7 kWhr per day per charge
- Each PEV will charge 320 days per year

Chargers/Demand:

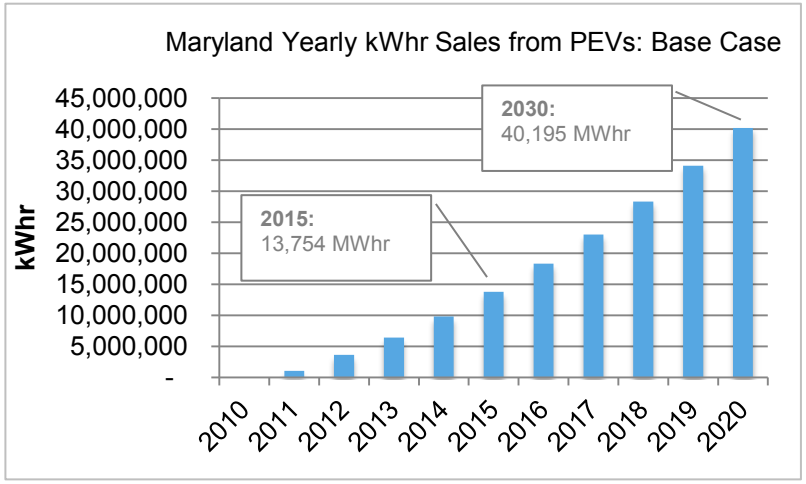
- The demand of a Level 2 charger is 7.68 kW
- The demand of a Level 1 charger is 1.4 kW

Other assumptions:

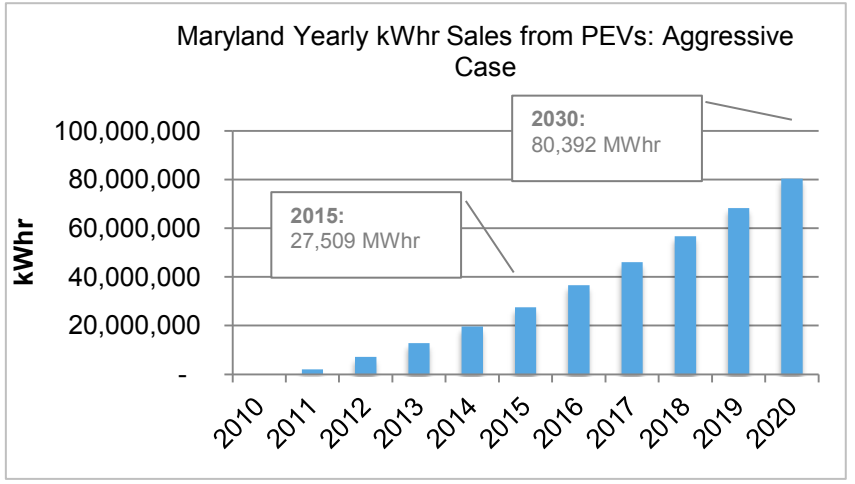
- 80% of chargers are Level 2 chargers, 20% are Level 1
- 90% of charging is done off-peak, 10% on-peak

Plug-In Vehicles' Impact on Load: Yearly MWhr

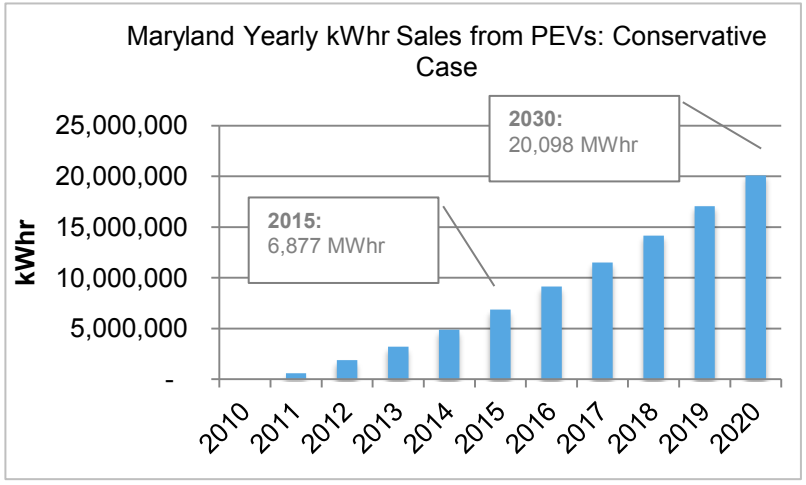
Base Case



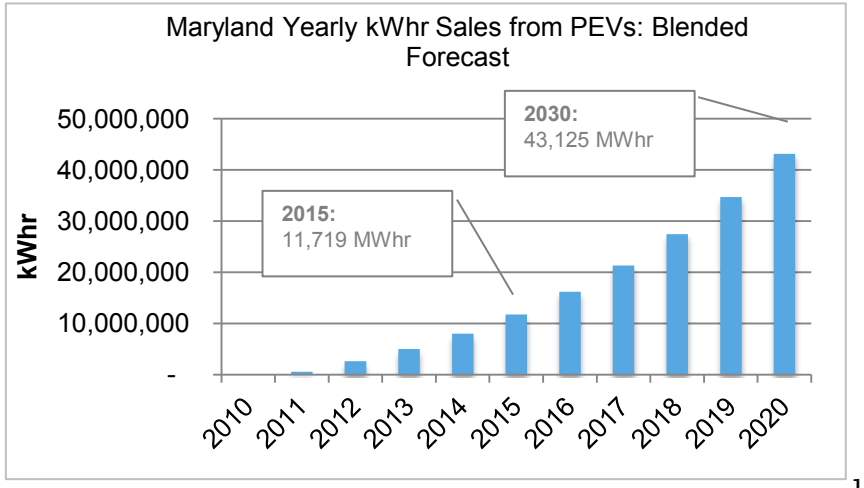
Aggressive Case



Conservative Case

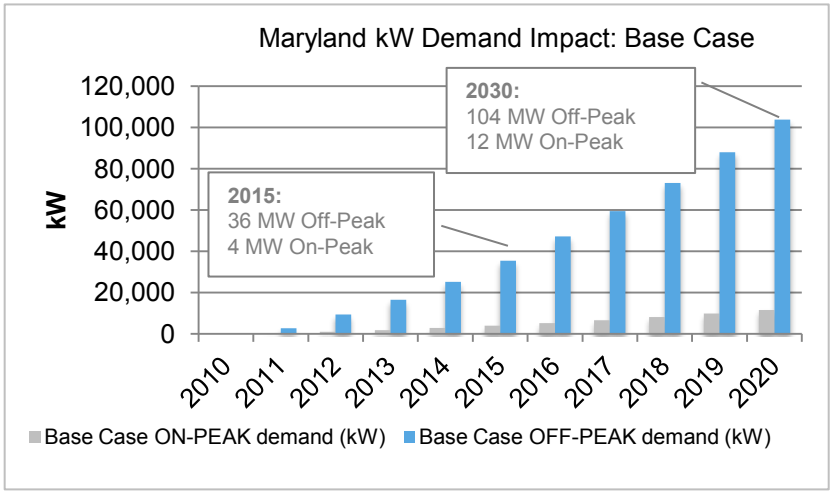


Blended Forecast



Plug-In Vehicles' Impact on Demand: MW

Base Case



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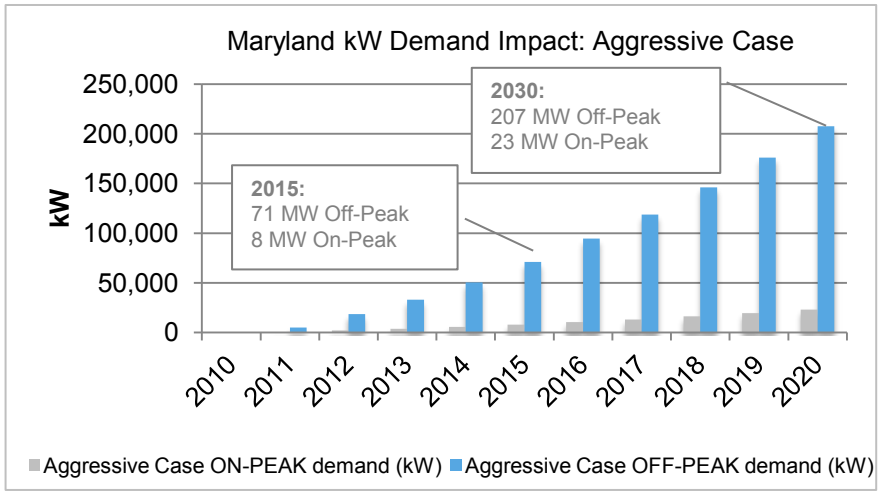

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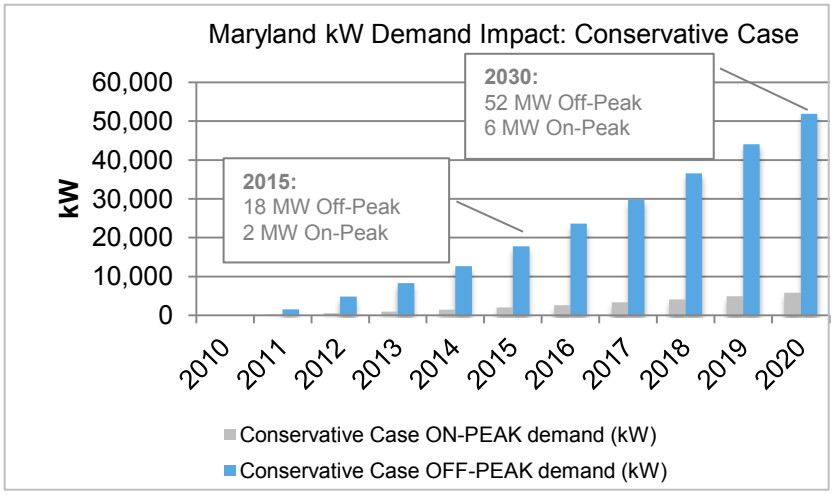

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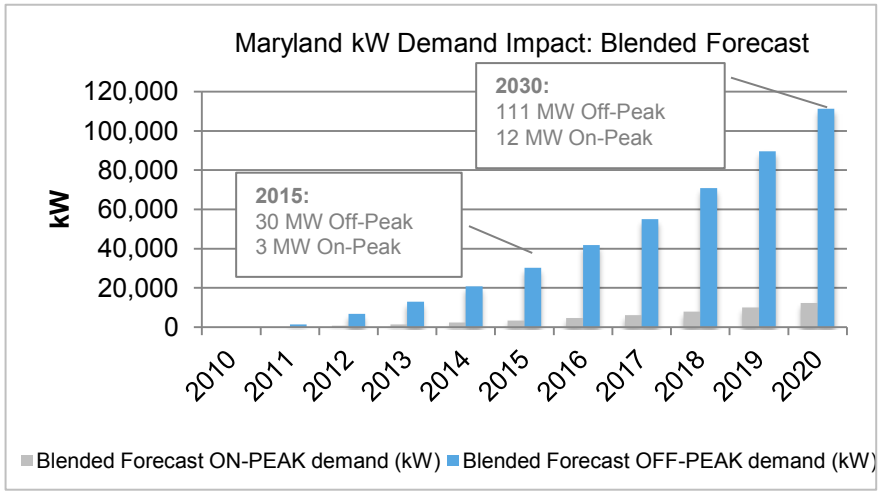
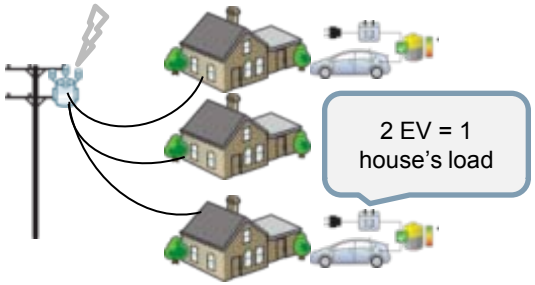
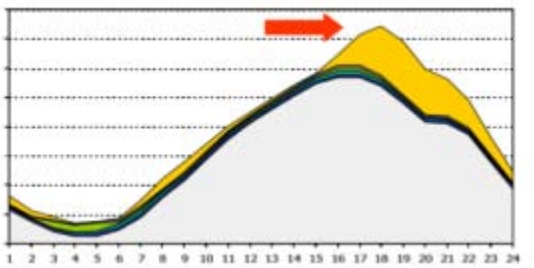


Unmanaged EV charging can create problems for utilities…..





Local Distribution System Impact

- EV load is equivalent to ½ to full home load, so adding EVs may overload local transformers
- Older, more affluent neighborhoods with higher concentrations of EVs will be particularly at risk (e.g., Washington, DC & Maryland Suburbs)

Peak Load Increase

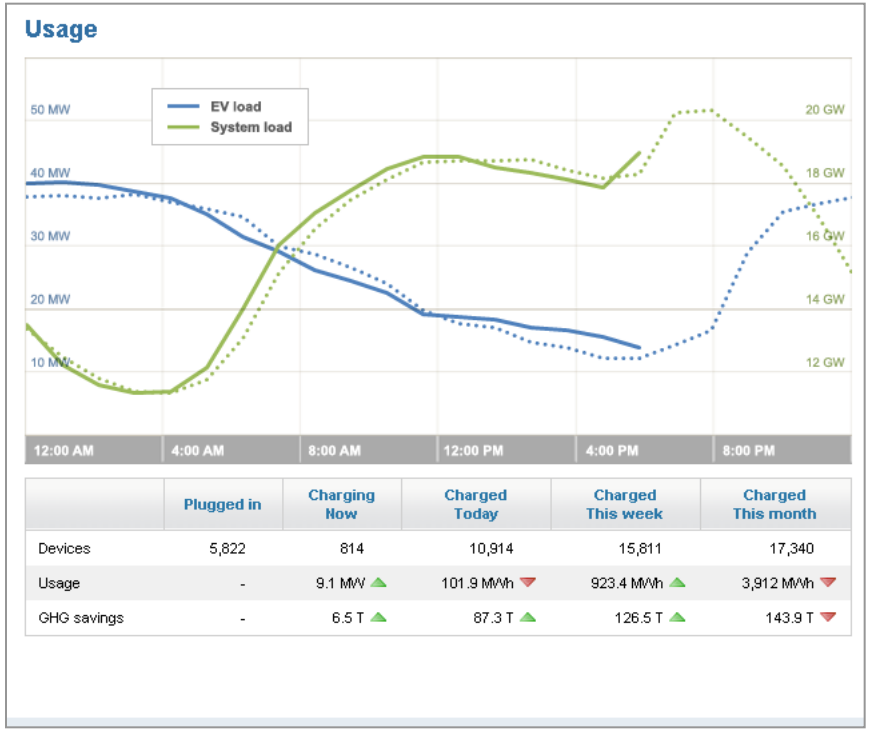
- Most drivers will return home and plug in between 4-8 PM, resulting in an increased afternoon peak
- Uncontrolled will create need for additional Infrastructure and result in longer and higher peak demand
- Impact to EmPower Maryland goals

Operational Needs

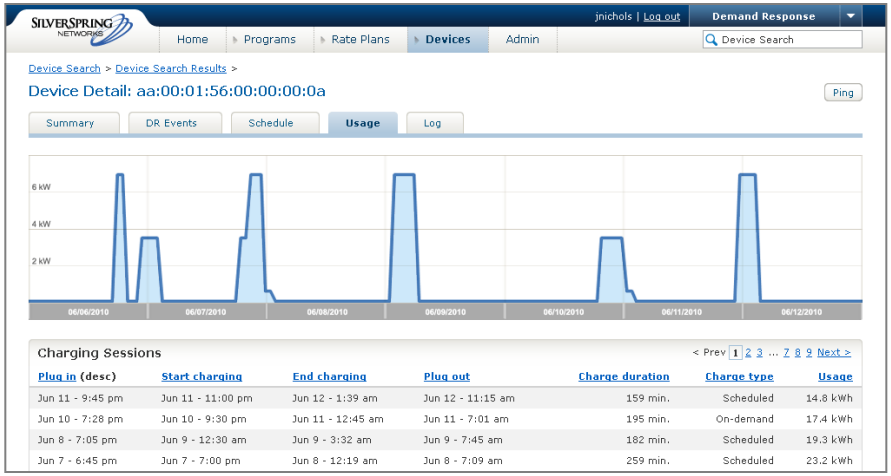
- Metering EVSE as separate load for billing, GHG credits
- Back-office integration of EVSE for control, billing
- Remote diagnostics for lower maintenance costs
- ***Need to avoid the need for installing a second meter by certifying the metrology in the chargers***

PEV Charging Managed by a Smart Grid

- EV Control and Monitoring Features:
  - EVSE device management (import/search/view/edit)
  - View EVSE usage data (plug in/out, charge start/stop)
  - Direct control of EVSE (start/stop charging)
  - Basic charge scheduling (static schedules)
  - Aggregated load impacts by transformer, feeder and substation

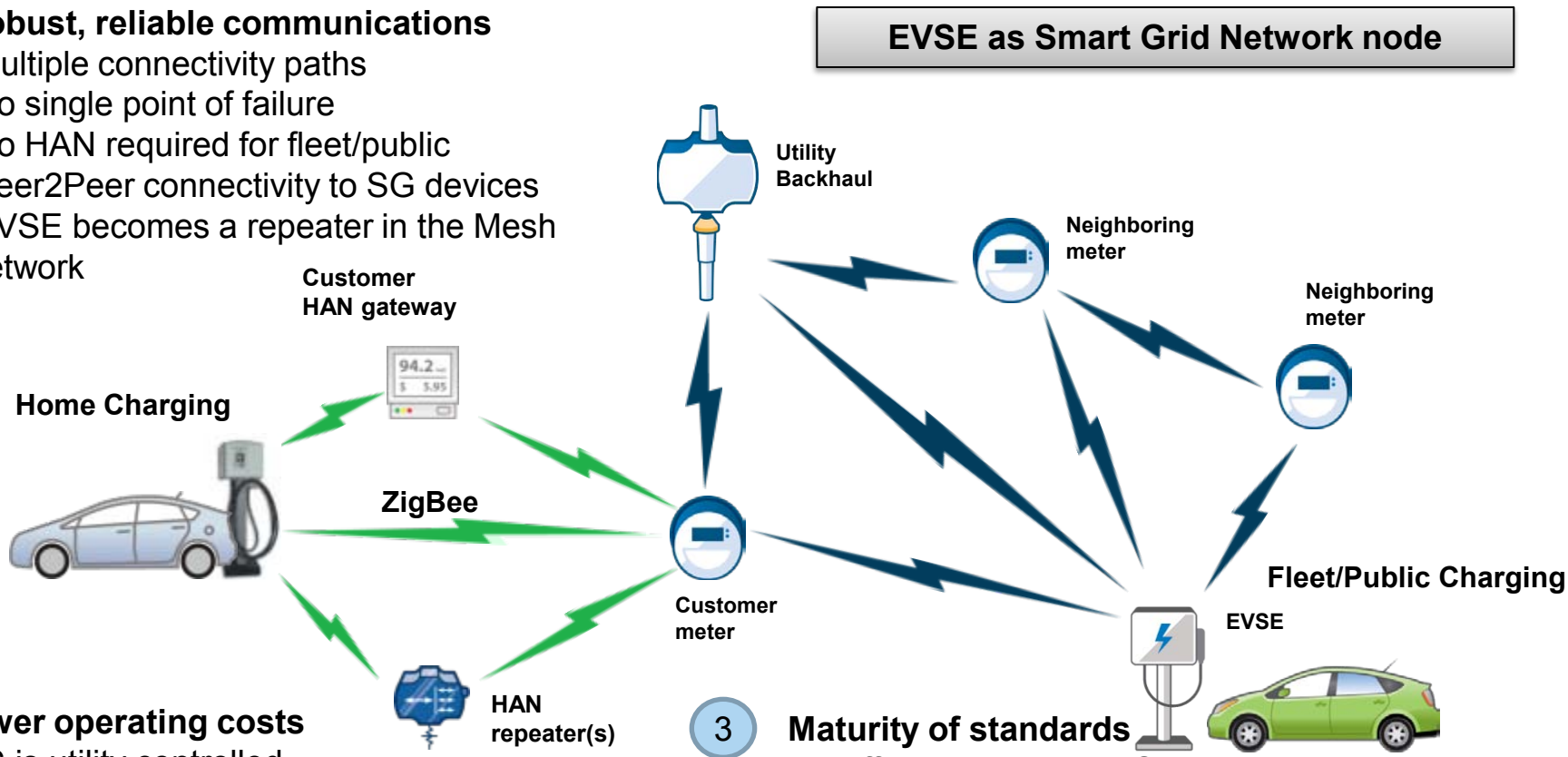


	Plugged in	Charging Now	Charged Today	Charged This week	Charged This month
Devices	5,822	814	10,914	15,811	17,340
Usage	-	9.1 MW ▲	101.9 MWh ▼	923.4 MWh ▲	3,912 MWh ▼
GHG savings	-	6.5 T ▲	87.3 T ▲	126.5 T ▲	143.9 T ▼



Benefits of EVSE as Smart Grid Node

1 **Robust, reliable communications**
- Multiple connectivity paths
- No single point of failure
- No HAN required for fleet/public
- Peer2Peer connectivity to SG devices
- EVSE becomes a repeater in the Mesh Network



2 **Lower operating costs**
- SG is utility controlled
- Charger integrated with existing SG Communications network

3 **Maturity of standards**
- Unaffected by ZigBee SEP upgrade issues
- Future-proofing with OTA upgrades

ClipperCreek EVSE Overview

Power
- Level 2: 240V, 30A

Communications
- Silver Spring Networks comms module
- 900MHz RF mesh radio, 2.4GHz HAN radio

Metrology
- ***Revenue-grade meter from TransData***
- Meets ANSI accuracy standards

User interface
- SAE-J1772™ Coupler
- Button for on-demand charging
- Charge indicator light
- Error indicator light

Charging features
- Charge on/low/off (low is configurable)
- In case of a fault, unit will auto-restart if possible

Possible Rate Options….

1

Time of Use

- Most frequently used EV tariff
- AMI Meter enables significant benefit
  - Communicates with Charger
  - Eliminates need for second meter
- Encourages off-peak charging

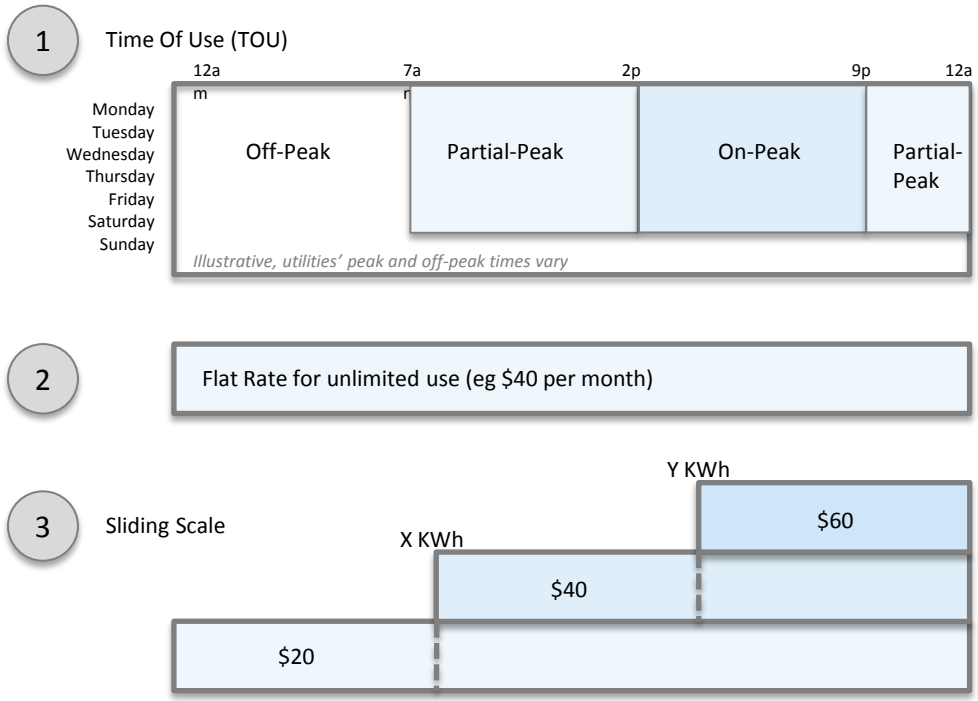
2 ***Flat EV Rate***

- Several utilities have introduced a variant of this rate
- Charge all you want for a flat fee
- Does not encourage off-peak charging

3 ***Sliding Scale - EV***

- Derivation on Flat Rate
- Rate ratchets with consumption
- Does not encourage off-peak charging

Example Rates for incentivizing EV Charging



Utility interface with car dealerships

Source of EV sales information

- Data on EV penetration
- Location of EV sales
- Information on future availability of EVs

Note: it is important to obtain this data at the premise address level (rather than high level zip code data)

Channel to communicate with customers

- Educational materials / Company brochure on EVs
- Location map of EV chargers
- Direct to Company website

This is a great opportunity to ensure utility is doing all it can with regards to customer outreach

Further consideration…..

- Further infrastructure reviews and modeling need to be conducted to better understand the distribution system impacts of vehicle charging
- We need to combine this with better information on vehicle penetration into each region
- A rate structure needs to be developed that will properly incentivize EV ownership and charging
- We need to educate customers and key stakeholders on the benefits of off-peak charging of electric vehicles
- How are utilities going to balance EV Deployment with State sponsored Energy Reduction goals ?

Moving Forward…..

Public Education

- Continue to reach out to local stakeholders
- Continue to participate in Customer Education programs and outreach to industry and research organizations

OEMs

- Continue vehicle demonstration / evaluation programs
- Continue to work collaboratively to integrate Plug-in Vehicles with the Smart Grid

Technology Readiness

- Integrate EV charger monitoring and control into existing Smart Grid Deployment
- Further evaluate system impacts of EV and charging
- Evaluate vehicle batteries in stationary applications
- Evaluate how EV's and other distributed resources will change the distribution system

Where is PHI now??

- Participating in EPRI / Ford Escape PHEV Program
- 2 Hybrid Bucket Trucks in fleet
- Will deploy 1 PHEV Bucket Truck in 2011
- Will deploy 10 Chevy Volts in fleet by Q3 2011
- 5 EVSE Charging Stations Installed
  - 2 Edison Place
  - 1 NCRO
  - 1 Bay Region
  - 1 ACE
- Demonstrate EV charger communication and management

Questions?